1260497

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

December 13, 2004

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: *60/520,613*
FILING DATE: *November 17, 2003*
RELATED PCT APPLICATION NUMBER: *PCT/US04/38585*

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

PTO/SB/16 (10-01)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

31281 U.S.PTO
60/520613
111703

22764 U.S.PTO

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a r quest for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. ER 332572325 US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Lawrence J.	Heaslip	Burlingtom, Ontario, CANADA
Dong	Xu	Mississauga,Ontario, CANADA
Johan	Richaud	Waterdown, Ontario, CANADA

☑ *Additional inventors are being named on the* 1 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

MULTI-OUTLET CASTING NOZZLE

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ Customer Number 25105 *Type Customer Number here* → Place Customer Number Bar Code Label here 25105 PATENT TRADEMARK OFFICE

OR

☐ Firm *or* Individual Name	Vesuvius
Address	27 Noblestown Road
Address	
City	Carnegie
State	PA
ZIP	15106-1632
Country	USA
Telephone	412-429-1800
Fax	412-276-7252

ENCLOSED APPLICATION PARTS ***(check all that apply)***

☑ Specification *Number of Pages* 11
☑ Drawing(s) *Number of Sheets* 6
☑ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☑ Other (specify) EXPRESS MAIL CERTIFICATE; RETURN RECEIPT POSTCARD

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.
☐ A check or money order is enclosed to cover the filing fees
☑ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 220281
☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($) 160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
☑ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted,

SIGNATURE Robert S. Klemz

Date Nov. 17, 2003

TYPED or PRINTED NAME Robert S. Klemz, Jr.

REGISTRATION NO. *(if appropriate)* 46305

Docket Number: 1463 US/PRO

TELEPHONE 412-429-1800 x252

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

Docket Number	1463 US/PRO

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
James D.	Dorricott	Burlington, Ontario, CANADA

Number 2 of 2

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	HEASLIP et al.
	)	
Title	)	MULTI-OUTLET
	)	CASTING NOZZLE
	)	
Attorney's Docket	)	1463 US/PRO

To: Mail Stop PROVISIONAL PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313-1450

Express Mail Certificate

Date of Deposit: NOVEMBER 17, 2003

To: Assistant Commissioner for Patents

I hereby certify that this correspondence is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" under 37 C.F.R. 1.10 on the date indicated above and was addressed to Mail Stop PROVISIONAL PATENT APPLICATION, Commissioner for Patents, P.O. Box 1450, Arlington, VA 22313-1450.

Express Mail number ER332572325US

Signature of person mailing correspondence

Thomas C. Dunford

Name of person mailing correspondence

CASTING NOZZLE WITH MULTIPLE OUTLETS

Background of the Invention

Liquid metal, and in particular liquid steel, is generally poured into a mold of a continuous casting machine through a casting nozzle. The casting nozzle generally comprises a refractory material and has a generally tube-like shape with one inlet to receive the liquid metal and one or more outlets to discharge the liquid metal. The liquid metal flows into the inlet of the nozzle, flows through the central bore of the nozzle, and flows out of at least one nozzle outlet. In the continuous casting of slabs, the nozzle is arranged generally vertically, with the outlet portion of the nozzle positioned within the upper part of a slab-shaped mold cavity so as to direct the metal flow into the upper part of the mold. In slab casting, it is often desirable to design the nozzle such that its outflow is divided into a least two streams that exit the nozzle from opposite sides of the nozzle in a nearly horizontal direction toward the narrow faces of the slab-shaped mold cavity. In this way, the majority of the hot liquid metal incoming to the mold is directed by the nozzle across the width of the slab so as to not impinge directly on the broad faces of the slab mold and so as to not plunge directly downward into the slab. A near horizontal direction of the exit streams discharging from the nozzle helps to provide more uniform temperatures at the top of the liquid metal pool in the mold to more uniformly melt the lubricating powder that is added to the top of the mold during casting and to reduce quality problems in the cast metal product such as cracking of the slab, or entrapment of non-metallic inclusions and gas bubbles in the cast metal products.

Description of the Related Art

A typical arrangement of a casting nozzle in a slab mold is shown in Fig.1. In order that opposing liquid metal streams exit the casting nozzle nearly horizontally, a nozzle is generally configured so as to turn the liquid metal flow away from the vertical toward the horizontal by means of a closed bottom directly below the central bore and opposed lateral outlets. The desired turning angle of the liquid metal flow in a casting nozzle used for slab casting is generally in the range of about 55 to about 105 degrees away from the vertical toward the horizontal depending on slab mold widths, casting rates, casting alloys, etc. as known to those skilled in the art.

Typically, casting nozzles with a central bore, a single bottom closure, and lateral outlets are used to turn the liquid metal flow from the nozzle nearly horizontally. A single simple bottom closure prevents the direct downward escape of the flow from the nozzle and thus the flow must turn toward the horizontal to escape through the opposing lateral outlets of the nozzle. The axes of the lateral outlets form an angle with the vertical axis of the central bore, called the design turning angle, as illustrated in Figs. 2, 3 and 4. For example, Fig. 2 illustrates a prior art slab-casting nozzle having a design turning angle of 90 degrees and two opposing lateral outlets. Fig. 3 illustrates a slab-casting nozzle having a design turning angle of 55 degrees and two opposing lateral outlets. Fig. 4 illustrates a prior art slab-casting nozzle having a design turning angle of 105 degrees and two opposing lateral outlets.

Such nozzles suffer from several deficiencies: (1) the exit streams do not achieve the design turning angle of the nozzles and their actual turning angle varies and wanders during casting operation, (2) the exit streams do not generally fully utilize the open area of the lateral outlets, and (3) the exit streams have a non-uniform velocity with the nozzle exit velocities in the lower portions of the exit streams being significantly higher than the

nozzle exit velocities in the upper portions of the exit streams, (4) the exit-streams penetrate too deeply into the liquid pool in the mould, and (5) the exit streams spin and swirl in a turbulent, and time-variant manner. These deficiencies lead to undesired and unstable patterns of liquid metal flow in the mold, the build-up of plugging deposits in the nozzle bore and nozzle outlets, and excessive turbulence in the nozzle exit streams and in the liquid metal pool in the mold. The net effect of these deficiencies is to adversely affect the operational performance of the casting machine and adversely affect the quality of the cast slabs.

Attempts to address these problems have been made in several ways that involve modifications to the design of the bottom closure of the nozzle. For example, to improve and stabilize the exit streams issuing from the opposed lateral outlets of nozzles, the bottom closure of the nozzle may be partially opened with a small hole as shown in Fig. 5, to allow a relatively small portion of liquid metal flow to exit the nozzle in a downward direction. A hole in the bottom closure weakens the exit streams exiting the lateral outlets. Weakening the turned exit streams reduces their wandering, but also reduces the quantity of flow that is turned toward the narrow faces of the mold and thus reduces the momentum or penetrating power of the turned exit streams to reach the narrow ends of the mold and if the bottom hole or holes are made too large, the near horizontal turning of the flow can be completely defeated.

Another method to improve and stabilize the exit-streams issuing from the opposed lateral outlets is to fashion a nozzle with a bottom closure located below the bottom of the outlets. A nozzle with a bottom closure located below the bottom of the outlets is shown in Fig. 6 and is referred to as a nozzle with a well-shaped bottom closure. Nozzles with a well-shaped bottom closure do not solve the above-mentioned deficiencies, as such nozzles still do not attain the design turning angle of the exit streams

and exit stream wandering still occurs. The uniformity of exit stream velocity is improved although not fully achieved with a well-shaped bottom casting nozzle, but swirling and turbulence of the exit streams is increased, decreasing their penetrating power and degrading the ability of the streams to reach the narrow faces of the mold with sufficient momentum to establish a consistent pattern of flow in the mold.

Another method to improve and stabilize the exit streams issuing from opposed lateral outlets is to fashion a nozzle with multiple lateral outlets. A nozzle with upper and lower lateral outlets is shown in Fig. 7. The nozzle of Fig. 7 has a simple central bore with constant open sectional area and opposing upper and lower lateral outlets above a closed bottom. Such nozzles also do not solve the above-mentioned deficiencies. The proportion of the liquid metal flow that is discharged from the upper lateral outlets is significantly less than that discharged from the lower lateral outlets, unless the total open area of the lower outlets is small relative to the open area of the central bore, in which case the exit streams from the upper outlets do not achieve the design turning angle and are swirling, turbulent, unstable, and wandering. If the total open area of the lower outlets is generally equivalent to or greater than the open area of the central bore, little or no exit stream flow will be discharged from the upper outlets and liquid metal can even flow into the nozzle through the upper outlets from the pool of metal in the mold, defeating the multiple outlet design. In either case, nozzles having a simple central bore with constant open sectional area and opposing upper and lateral outlets above a closed bottom do not solve the above-mentioned deficiencies.

A second nozzle with upper and lower lateral outlets above a closed bottom, as taught by Saito et al in U.S. Patent 4,949,778, is shown in Fig. 8. In this patent, Saito et al teach a casting nozzle, wherein at least one portion of the central bore of the nozzle is reduced in open sectional area in all radial directions around the central axis of the

nozzle. The nozzle also includes opposed lateral outlets, having a total open area not less than twice the open sectional area of the central bore before reduction, the outlets being arranged above and below the reduced portion or portions of the central bore. Saito et al also teach a set of mathematical equation relations between; the open areas of the nozzle outlets, the open area of the central bore, the open areas of the central bore after reduction, and a discharge coefficient. Figs. 8(a), 8(b), and 8(c) are reproductions of the figures used in U.S. Patent 4,949,778 referring to a first embodiment of the Saito et al invention, while Fig. 8(d) is a perspective view that shows the salient features of the nozzle of Saito et al in a 3-dimensional view for better clarity. The drawings of Saito et al teach reduction of sectional area of the central bore of a nozzle by reducing the diameter of the central bore, or in other words, by reducing the sectional area of the central bore in all radial, or horizontal, directions around the vertical central axis of the central bore. This reduction forms a ledge-like surface that extends around the entire circumference or perimeter of the central bore and forms a bore below the ledge that is narrower in all radial directions than the bore above the ledge. Thus in accordance with the teachings of Saito et al, the lower outlets are restricted in width by the reduced bore and thus upper outlets are wider than lower outlets, and in accordance with the mathematical relations and other patent teachings, the lower outlets must be taller than they are wide. However, it has been found that nozzles fashioned in accordance with the teachings of Saito et al in U.S. Patent 4,949,778 have several deficiencies. The lower outlets have a high vertical aspect ratio, that is to say that their height is greater than their width and thus the exit streams do not fully utilize the open area of the lower lateral outlets, and the exit streams have a non-uniform velocity with the nozzle exit velocities in the lower portions of the exit-streams being significantly higher than the nozzle-exit velocities in the upper portions of the exit streams. The presence of the circumferential

ledge-like surface that extends around the entire perimeter of the central bore of the nozzle causes uncontrolled spinning and swirling of the upper exit streams that are discharged from the upper outlets. Another deficiency is that, in the case of multiple reduction of the central bore, the uppermost outlets approach close to the surface or meniscus of the liquid metal in the mould increasing the level fluctuation and turbulence at the meniscus.

Objects of the Invention

It is an object of the invention to provide a casting nozzle comprising upper and lower lateral outlets, wherein the liquid metal exit-streams, discharged from the nozzle through the lateral outlets, are turned substantially away from the vertical toward the horizontal by means of a bottom closure of the central bore of the nozzle and by means of at least one lateral constriction of the central bore formed by at least one intrusion into the central bore by the lower edge of an upper lateral outlet.

It is an object of the invention to provide a casting nozzle, comprising a central bore, bottom closure, and upper and lower lateral outlets, which divide the liquid metal flow discharged from the nozzle into upper and lower lateral exit streams, turned substantially from the vertical toward the horizontal.

It is a further object of the invention to provide a casting nozzle that produces upper and lower lateral exit streams that issue from upper and lower lateral outlets, achieving a desired proportion of liquid metal flow discharge in each exit-stream and achieving a desired turning angle of each exit-stream.

It is a further object of the invention to provide a casting nozzle comprising upper and lower lateral outlets, wherein the vertical aspect ratios, as defined by the ratio of outlet height to outlet width, of all the outlets are preferably one or less.

It is a further object of the invention to provide a casting nozzle comprising upper and lower lateral outlets, wherein the width of lower lateral outlets are preferably not decreased as compared to the width of upper lateral outlets.

It is a further object of the invention to provide a casting nozzle comprising upper and lower lateral outlets, wherein the total open area of the outlets is preferably less than twice, and preferably more than equal to, the open area of the central bore of the nozzle above the outlets.

Description of the Invention

Figs. 9 and 10 show views of a first embodiment of a casting nozzle of the invention. Fig. 9(a) is a side view, Fig. 9(b) is a sectional front view, Fig. 9(c) is a sectional top view, and Fig. 9(d) is a perspective view. Fig. 10 is the same view as Fig. 9(b) with additional labeling. In this embodiment, the design turning angle from the vertical upward toward the horizontal of the upper outlets is 90 degrees as is the design turning angle of the lower outlets. Each upper outlet is defined by an upper edge and a lower edge. The central bore of the casting nozzle is laterally constricted by the lower edges of the upper outlets. The lateral constriction is formed by the intrusion of only the lower edges of the upper outlets into the central bore and thus the lateral opening of the central bore above the upper edges of the upper outlets is greater than the lateral opening of the central bore at the lower edges of the upper outlets. The lower outlets are located below the constriction and above a bottom closure. A lateral constriction does not take the form of a circumferential ledge-like surface that extends around the entire perimeter of the central bore of the nozzle. As can be seen in Figs. 9(a), 9(c) and 9(d), a lateral constriction only reduces the lateral opening of the central bore, and thus the dimension of the central bore opening at 90 degrees to the lateral opening is unchanged. The design turning angles of the upper and lower outlets need not be necessarily equal to 90 degrees.

Also the design turning angles of the upper and lower outlets can differ. In either case, the design turning angles will typically be in the range of about 55 to about 105 degrees as measured from the vertical upward toward the horizontal in order that a nozzle of the invention achieves multiple exit streams turned nearly horizontally relative to a vertical central bore.

As shown in Fig. 9, the width of the lower lateral outlets are preferably not decreased with respect to the width of the upper lateral outlets and also as shown in Fig. 9, the height of the lateral outlets is preferably less than the width of the lateral outlets. The total open area of the outlets is preferably less than twice the open area of the central bore of the nozzle above the outlets, and preferably more than equal to the open area of the central bore of the nozzle above the outlets. A nozzle of the invention achieves the desired turning of the flow toward the near horizontal, while achieving, as compared to other nozzles, better filling of the outlets by the exit streams to inhibit clogging, more uniform exit flow velocities, and more stable and controlled exit streams with significantly reduced spinning and swirling to provide a more desirable and consistent pattern of flow in the mold.

In nozzles of the invention, the achieved turning angles of the exit streams are controlled by the angles of the lower edges of the outlets relative to the vertical central axis of the bore and multiple turning angles and multiple constrictions can be used. Figures 11 and 12 show views of a first embodiment of a casting nozzle of the invention. Fig. 11(a) is a side view, Fig. 11(b) is a sectional front view, Fig. 11(c) is a sectional top view, and Fig. 11(d) is a perspective view. Fig. 12 is the same view as Fig.11 (b) with additional labeling. This embodiment of the invention has two opposing pairs of upper lateral outlets above one another and one opposing pair of lower lateral outlets below. In this embodiment, the design turning angle from the vertical toward the horizontal of the

top upper outlets is 90 degrees, the design turning angle of the middle upper outlets is 75 degrees, while the design turning angle of the lower outlets is 60 degrees. Each upper outlet is defined by an upper edge and a lower edge. The central bore of the casting nozzle is constricted in only the lateral direction by the lower edges of the upper outlets. Each lateral constriction is formed by the intrusion of the lower edges of the upper outlets into the central bore and thus the lateral opening of the central bore above the upper edge of an upper outlet is greater than the lateral opening of the central bore at the lower edge of the same upper outlet. This second embodiment has two constrictions. Considering the lateral opening of the central bore at the top edge of the uppermost outlets and moving downward in the direction of the flow through the central bore, only the lateral opening of the central bore is decreased in a step-wise manner with each successive constriction. The lateral constrictions do not take the form of circumferential ledge-like surfaces that extend around the entire perimeter of the central bore of the nozzle. As can be seen in Figs. 11(a), 11(c) and 11(d), the lateral constrictions only reduce the lateral openings of the central bore, and thus the dimension of the central bore opening at 90 degrees to the lateral openings is unchanged. The lower outlets are located below the lowermost constriction and above the bottom closure. As shown in Fig. 11, the width of a lateral outlet preferably does not decrease with respect to the width of an above lateral outlet and, also as shown in Fig. 11, the height of the lateral outlets is preferably less than the width of the lateral outlets. The total open area of the lateral outlets is preferably less than twice the open area of the central bore of the nozzle above the outlets and more than equal to the open area of the central bore of the nozzle above the outlets.

At least one constriction of the central bore of a casting nozzle by the intrusion into the bore by the lower edge of an upper outlet, above a lower outlet of the nozzle, and above a bottom closure of the nozzle is a feature of the invention. The bottom of the

nozzle should be substantially closed to stabilize the backpressure in the liquid metal flowing through the nozzle and at least one lateral constriction is used to turn a certain portion of the flow to form an upper exit stream, while a remainder of the flow is subsequently turned by the bottom closure to from a lower exit stream. This sequential division and turning of the flow in a nozzle of the invention causes the discharge rate and velocity of liquid metal issuing from each outlet, and the discharge angles of the exit streams, to display significantly less fluctuation as compared to the nozzles discussed above. A lateral constriction does not take the form of a circumferential ledge-like surface that extends around the entire perimeter of the central bore of the nozzle. Instead, a lateral constriction only reduces the lateral opening of the central bore, the dimension of the central bore opening at 90 degrees to the lateral opening is unchanged by a constriction of the invention. Thus no decrease in the width of lower lateral outlets with respect to the width of upper lateral outlets is required and low vertical aspect ratios of the lateral outlets are allowed. The vertical aspect ratio of a lateral outlet is defined as the ratio of outlet height to outlet width. Preferably, all of the lateral outlets have vertical aspect ratios less than one. It has been found that low vertical aspect ratios of the lateral outlets remarkably stabilize the exit-streams to achieve, as compared to other nozzles, better filling of the outlets to inhibit clogging, more uniform exit-flow velocities of the exit-streams, significantly reduced spinning and swirling of the exit-streams, and a surprisingly consistent pattern of flow in the mould with less turbulence. A casting nozzle of the invention with low vertical aspect ratios of the outlets and with a total open area of the lateral outlets less than twice, and more than equal to, the open area of the central bore above the outlets allows close approach of the uppermost outlets to the meniscus, and thus even more than two constrictions can be utilized without fear of meniscus disruption.

In nozzles of the invention, multiple nearly horizontal upper and lower exit streams with turning angles between about 55 and about 105 degrees from the vertical toward the horizontal are readily and stably achieved. The achieved turning angles more closely match the design turning angles, as compared to nozzles of the prior art. Different steady turning angles of the upper exit streams and lower exit streams can be readily realized, as well as a more certain and stable division of the flow into multiple upper and lower exit streams. This accomplishes a highly diffuse, but still near horizontal, introduction of liquid metal into a slab mold that is highly desirable for high throughput casting and overcomes the deficiencies of other nozzles.

Adjusting the extent of a lateral constriction controls the proportion of the liquid metal flow that exits the nozzle through the upper outlet whose lower edge protrudes into the central bore to form the constriction. The extent of the lateral constriction is defined by the ratio of the open area of the central bore in the horizontal plane at the constriction as compared to the open area of the central bore in a horizontal plane above the constriction. Thus, the designer can adjust with greater certainty and simplicity, as compared to other nozzles, the proportions of the total flow exiting a nozzle of the invention through each upper lateral outlet.

Obviously, numerous modifications and variations of the present invention are possible. It is, therefore, to be understood that within the scope of the following claims, the invention may be practiced otherwise than as specifically described.

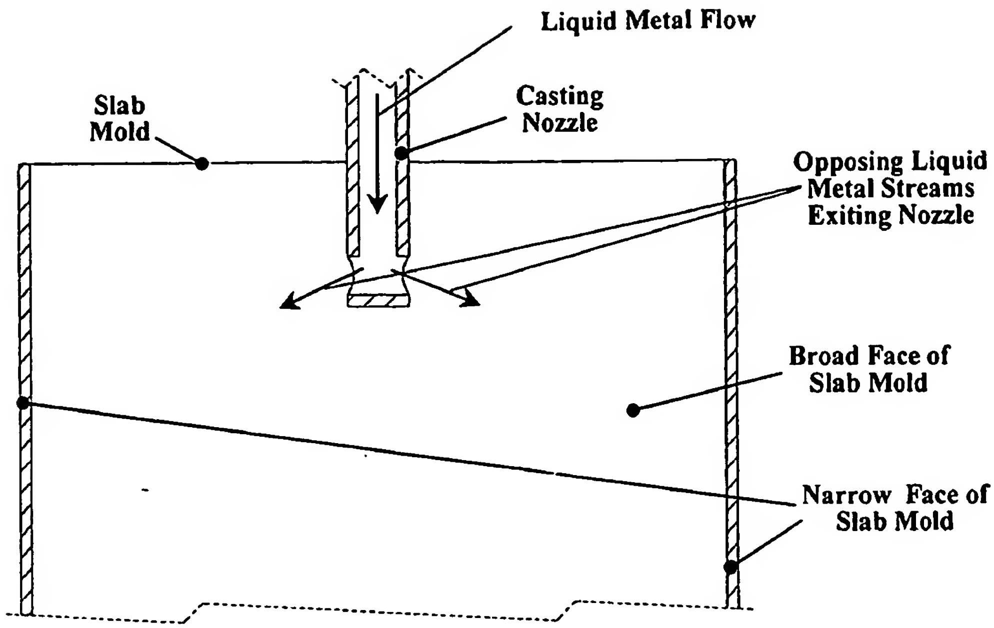

Figure 1: Section View of a Casting Nozzle in Slab Mold

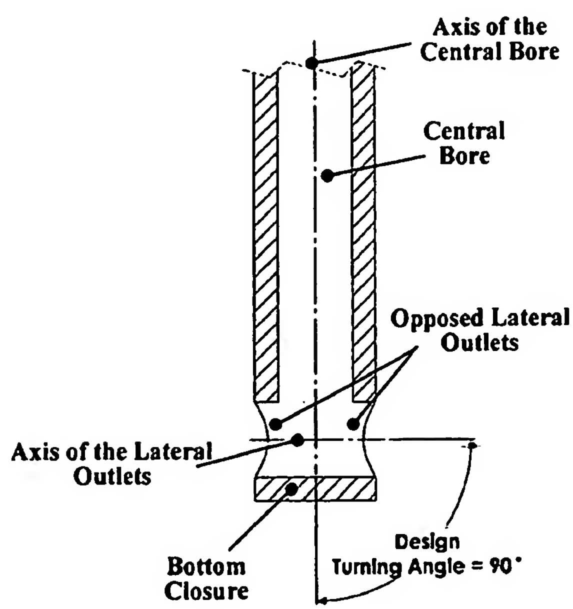

Figure 2: Section View of a Casting Nozzle with Design Turning Angle of 90 Degrees

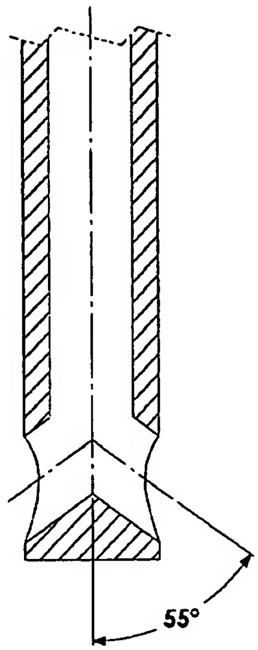

Figure 3: Section View of a Casting Nozzle
with Design Turning Angle of 55 Degrees

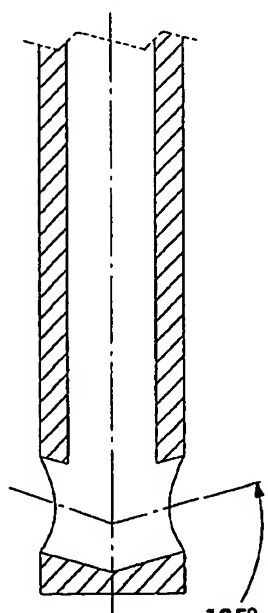

Figure 4: Section View of a Casting Nozzle
with Design Turning Angle of 105 Degrees

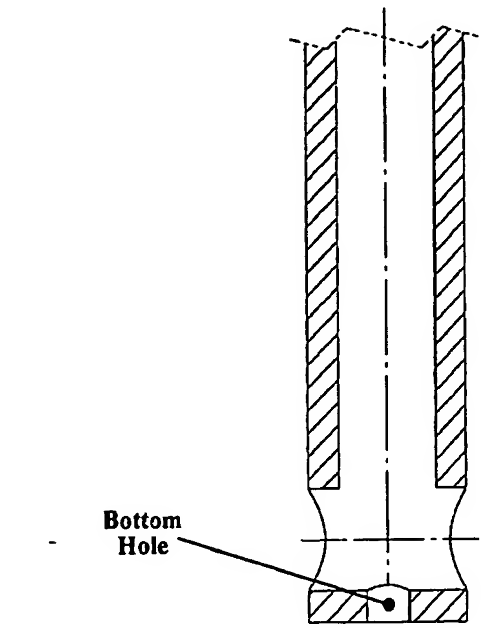

Figure 5: Section View of a Casting Nozzle
with Bottom Hole

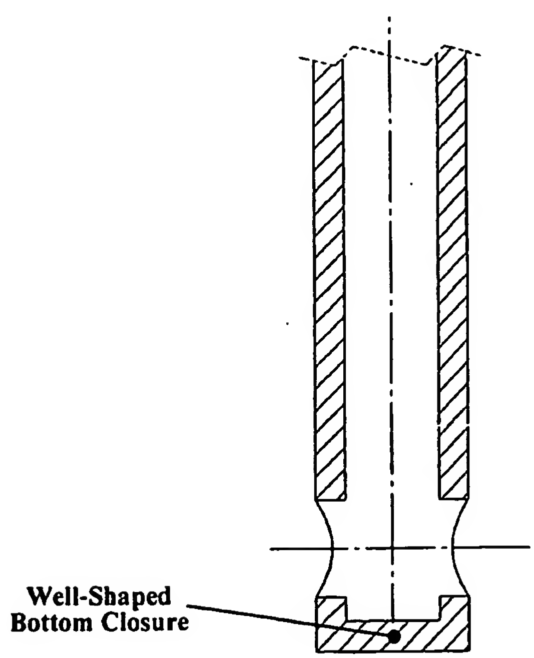

Figure 6: Section View of a Casting Nozzle
with Well-Shaped Bottom Closure

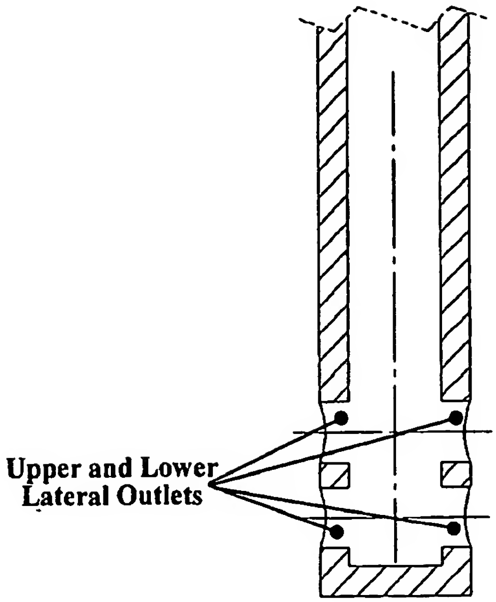

Figure 7: Section View of a Casting Nozzle
with Upper and Lower Lateral Outlets

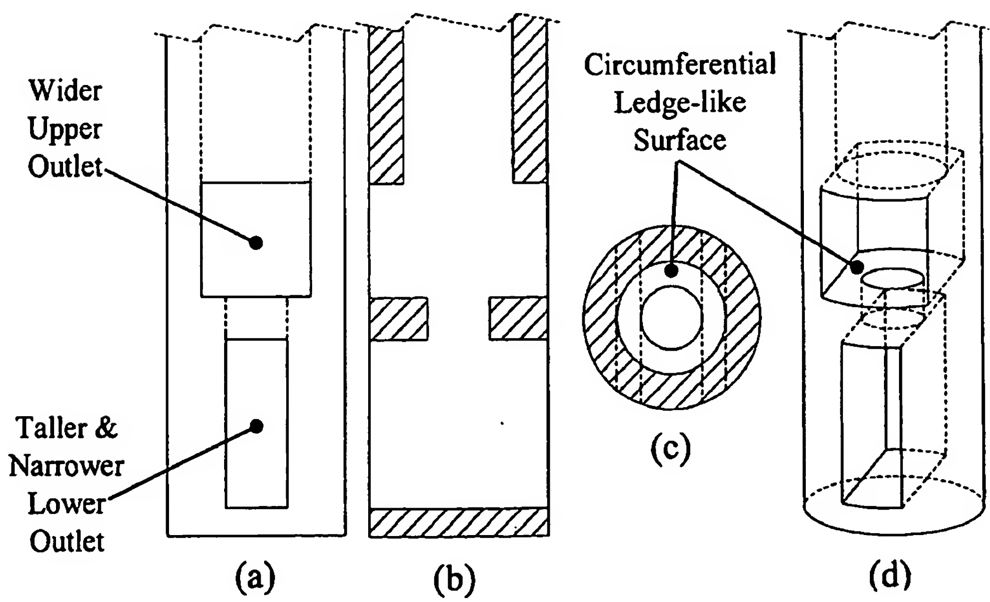

Figure 8: Views of a Casting Nozzle
Fashioned in Accordance with the Teachings of Saito et al

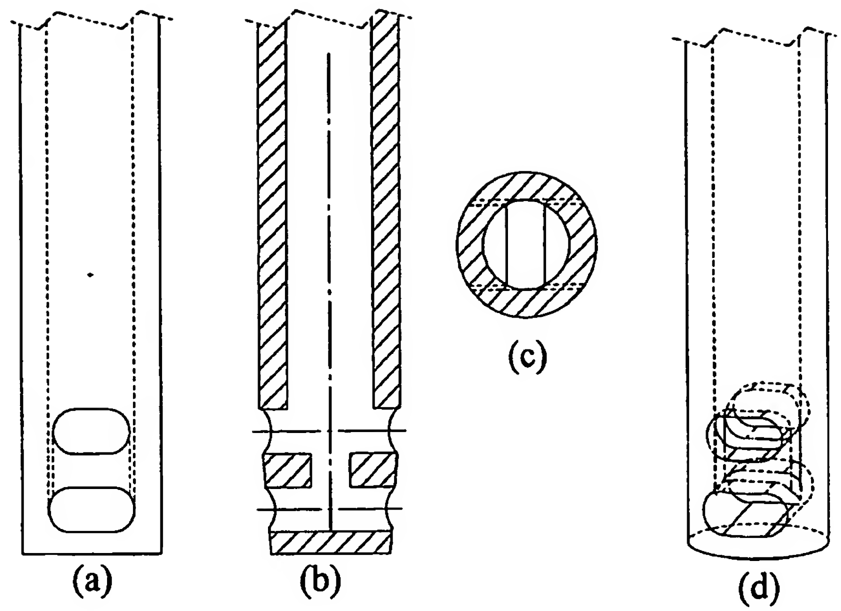

Figure 9: Views of a First Embodiment of a Casting Nozzle of the Invention

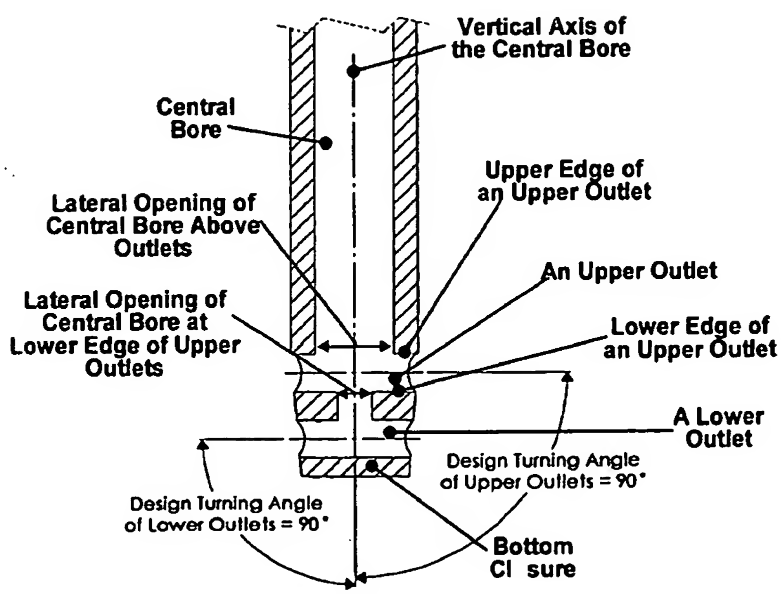

Figure 10: Section View of a First Embodiment of a Casting Nozzle of the Invention

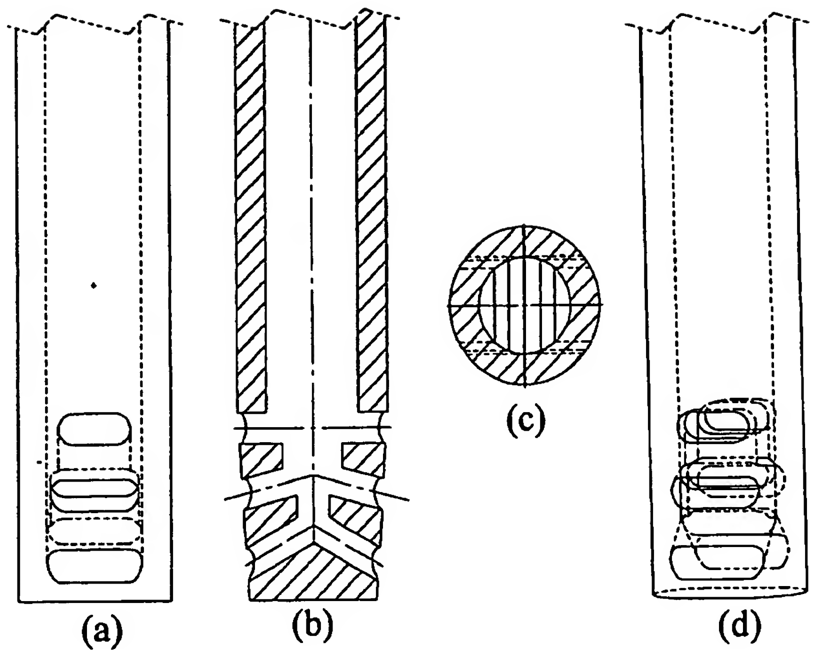

Figure 11: Views of a Second Embodiment of a Casting Nozzle of the Invention

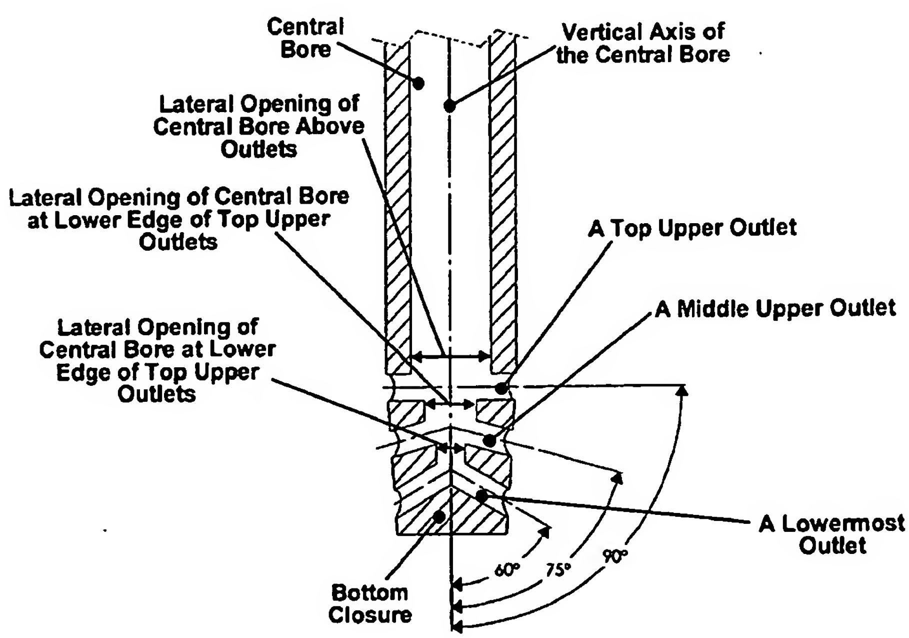

Figure 12: Section View of a Second Embodiment of a Casting Nozzle of the Invention

Application Data Sheet

Application Information

Application Type:	Provisional
Subject Matter:	Utility
Suggested Classification:	
Suggested Group Art Unit:	
CD-ROM or CD-R?	None
Title:	MULTI-OUTLET CASTING NOZZLE
Request for Early Publication?:	No
Request for Non-Publication?:	No
Suggested Drawing Figure:	Fig. 9
Total Drawing Sheets:	6
Small Entity:	No
Petition Included?:	No
Secrecy Order in Parent Appl.?:	No

Applicant Information

Applicant Authority Type:	Inventor
Primary Citizenship Country:	CANADA
Given Name:	Lawrence J.
Family Name:	Heaslip
City of Residence:	Burlington
State of Residence:	Ontario
Country of Residence:	CANADA
Street of mailing address:	4375 Spruce Avenue
State of mailing address:	Ontario
Zip Code of mailing address:	L7L-5V2

Applicant Information

Applicant Authority Type:	Inventor
Primary Citizenship Country:	CHINA
Given Name:	Dong
Family Name:	Xu
City of Residence:	Mississauga
State of Residence:	Ontario
Country of Residence:	CANADA
Street of mailing address:	3016 Hawktail Crescent
State of mailing address:	Ontario
Zip Code of mailing address:	L5M-6W3

Applicant Authority Type:	Inventor
Primary Citizenship Country:	FRANCE
Given Name:	Johan
Family Name:	Richaud
City of Residence:	Waterdown
State of Residence:	Ontario
Country of Residence:	CANADA
Street of mailing address:	6 Waterwheel Crescent
State of mailing address:	Ontario
Zip Code of mailing address:	L9H-7B6

Applicant Authority Type:	Inventor
Primary Citizenship Country:	CANADA
Given Name:	James
Family Name:	Dorricott
City of Residence:	Burlington
State of Residence:	Ontario
Country of Residence:	CANADA
Street of mailing address:	2093 Simco Dr.
State of mailing address:	Ontario
Zip Code of mailing address:	L7M-4E8

Correspondence Information

Correspondence Customer Number: 25105

Representative Information

Representative Customer Number: 25105

Domestic Priority Information

Application:	Continuity Type:	Parent Application:	Parent Filing Date:
None			

Foreign Priority Information

Country:	Application Number:	Filing Date:	Priority Claimed:
None			

Assignee Information

Assignee Name: Vesuvius Crucible Corporation
Assignee Address: 103 Foulk Road
Assignee City: Wilmington
Assignee State: DE
Assignee Zip Code: 19803

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US04/038585

International filing date: 17 November 2004 (17.11.2004)

Document type:	Certified copy of priority document	
Document details:	Country/Office:	US
	Number:	60/520,613
	Filing date:	17 November 2003 (17.11.2003)

Date of receipt at the International Bureau: 07 January 2005 (07.01.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)